Programmable Counters & Timers

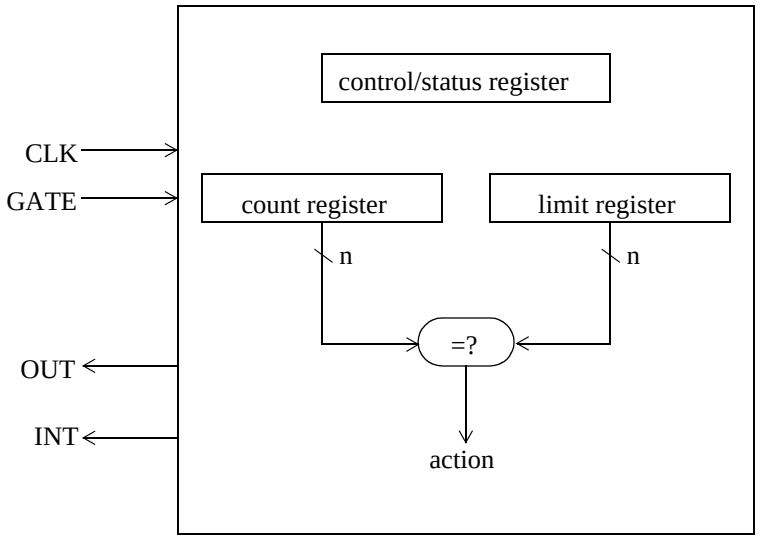
A programmable counter/timer is a flexible microprocessor peripheral that counts the edges (voltage transitions) that occur on an input signal. A counter/timer device has two basic applications:

1. count events

2. measure time

Why might you want a separate device to perform these functions?

Generic Counter/Timer



Basic operation:

- Your program initializes register values (typically count register is initialized to 0).
- On each (e.g., falling) edge of CLK, value in count register is incremented.
- When count register = limit register, things happen... as determined by control register settings

This diagram shows an *upcounter*. *Downcounters* are similar (actions occur when the count register reaches 0).

Programmable Counter/Timer Options

Flexiblity comes because you can program (via the control register(s)) much of the device's behavior.

What happens when count = limit?

- always set bit in status register
- may generate interrupt to CPU
- may reset count to 0
- may continue counting, or stop
- may change signal on OUT pin: set, clear, pulse, toggle

May have additional GATE signal that can be programmed to:

- enable/disable counting of CLK edges
- reset count to 0 on edge

Counter/Timer Applications

1. Interval timer
2. Clock divider
3. Watchdog timer
4. Frequency counter

MPC823 Timers

See Section 16.4 of the data book.

- MPC823 has four 16-bit timers on chip
  - ERRATA: only two of them (1 & 2) work
- Each has external input pin (TIN1, TIN2, TIN3, TIN4)
  - other inputs: system clock, system clock divided by 16
  - also used for “capture mode”
- Only 1 & 2 have output pins ($\overline{\text{TOUT1}}$ & $\overline{\text{TOUT2}}$)
  - active-low pulse for one input clock
  - toggle
- Only one gate input ($\overline{\text{TGATE1}}$), can be used with 1 or 2
  - ignore
  - enable when low, disable when high
  - same, but also reset counter on falling $\overline{\text{TGATE1}}$ edge

MPC823 Timer Control Registers

- TGCR (Timer Global Config Register)
  - can pair two to act as a 32-bit timer (1&2 and/or 3&4)
  - power control
  - gate mode

For each timer x:

- mode (control/status) register TMRx
  - prescaler value
  - capture mode enable/edge type
  - output mode
  - interrupt enable
  - input clock source
  - gate enable

Other MPC823 Timer Registers

- reference (limit) register TRRx
- counter register TCNx
- capture register TCRx
- event register TERx: bits to indicate
  - “reference event” (limit reached)
  - “capture event” (CTRx valid)